

Figure 2. Topography of the Mobile River Basin.

factors. This diversity, in part, comes from the basin landscape, which ranges from steep mountains and plateaus in the northeast to broad, flat plains and rolling hills to the south and west (fig. 2). This variable landscape correlates with natural changes in geology and hydrology. Cultural influences in the basin include abundant rural expanses of forested areas, cropland, and pastures that are interspersed with cities and small towns. These combinations of natural and human factors are the principal influences on water quality.

Natural Factors

The physiography, geology, soils, climate, hydrology, and ecology of the Mobile River Basin all combine to create a unique, diverse setting. The geology and soils are the primary factors affecting the chemical composition of ground and surface waters. These natural factors discussed in this report are those which generally control water-quality characteristics in the absence of human activities.

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Physiography

The Mobile River Basin encompasses parts of five physiographic provinces (fig. 3). Fifty-six percent of the basin lies within the East Gulf Coastal Plain section of the Coastal Plain Physiographic Province (referred to in this report as the Coastal Plain Physiographic Province). The northeastern part of the basin lies, from west to east, within the Cumberland Plateau section of the Appalachian Plateaus Physiographic Province (referred to in this report as the Cumberland Plateau), the Valley and Ridge Physiographic Province, the Piedmont Physiographic Province, and the Blue Ridge Physiographic Province.

Non-Coastal Plain Physiographic Provinces

About 44 percent of the Mobile River Basin lies within the non-Coastal Plain Provinces. Of these provinces, the Valley and Ridge accounts for 16 percent of the basin; the Piedmont, 15 percent; the Cumberland Plateau, 12 percent; and the Blue Ridge, 1 percent. These four provinces occupy the northern part of the study unit and include a wide range of geologic and topographic settings.

The boundary between the Coastal Plain and the non-Coastal Plain Provinces is marked by the Fall Line, or more accurately a zone along which the rivers and streams flow across resistant rocks that mark the boundary between these two provinces. River channels along the Fall Line are characterized by shoals and rapids produced by preferred erosion of the poorly consolidated Coastal Plain sediments (Journey and Atkins, 1997).

Blue Ridge and Piedmont Physiographic Provinces

The northeastern corner of the Mobile River Basin lies within the southern tip of the Blue Ridge Physiographic Province and is dominated by rugged mountains and ridges as high as 4,100 feet above sea level. The Piedmont borders the Blue Ridge Physiographic Province to the south (fig. 3). The Blue Ridge and Piedmont Physiographic Provinces are underlain mostly by Precambrian-age and older Paleozoic-age crystalline rocks that form the core of the ancient Appalachian Mountains. When first formed, the mountains would have rivaled the present day Himalayas in elevation. Over the intervening 200 million years, however, the mountains have eroded to their present level (McConnell, 1998). The Piedmont Physiographic Province is the nonmountainous part of

the older Appalachians. Rarely is the land surface parallel to bedrock, and nowhere is the original surface preserved (Sanders and others, 1999). The Blue Ridge is distinguished from the Piedmont primarily by its greater topographic relief (Clark and Zisa, 1976). The Piedmont forms a well-dissected upland characterized by rounded interstream areas to the north and by rolling topography, indicative of a dissected peneplain of advanced erosional maturity, to the south (Chandler and Lines, 1974). Land-surface altitude in the Piedmont ranges from about 500 to 1,500 feet above sea level.

Valley and Ridge Physiographic Province

The Valley and Ridge Physiographic Province consists of a series of northeast-trending linear ridges and valleys underlain by alternating beds of hard and soft Paleozoic sedimentary rocks, which are highly faulted and folded and range in age from Cambrian to Pennsylvanian. Resistant sandstone and chert underlie the ridges, and softer shale and limestone underlie the valleys. Altitudes in the Mobile River Basin range from 600 to 1,600 feet above sea level on the ridges to 400 to 900 feet in the valleys (Robinson and others, 1997).

Cumberland Plateau

The north-central part of the Mobile River Basin lies within the Cumberland Plateau section of the Appalachian Plateaus Physiographic Province. The Appalachian Plateaus includes nearly horizontal layers of Mississippian- and Pennsylvanian-age rocks formed adjacent to the ancient Appalachians. Sediment eroded from the mountains was carried westward by streams and deposited in deltas in the area now called the Appalachian Plateaus (McConnell, 1998). The Cumberland Plateau consists of rock similar to the Valley and Ridge, but lacks the many folds and faults of the Valley and Ridge. This region is a submaturely to maturely dissected upland underlain by nearly flatlying rocks of Pennsylvanian age, but the region also contains anticlinal valleys of older Paleozoic-age limestone and dolomite. Altitudes range from 1,500 to 2,000 feet above sea level in the northeast to about 500 feet above sea level in the western part of the Cumberland Plateau.

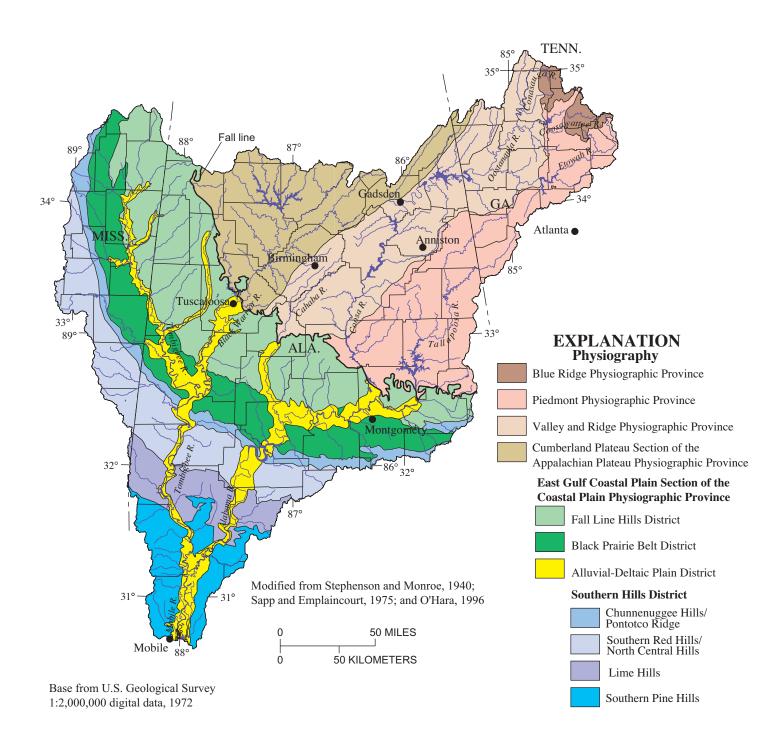


Figure 3. Physiography of the Mobile River Basin.

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Coastal Plain Physiographic Province

The Coastal Plain Physiographic Province is separated into four districts: (1) Fall Line Hills, (2) Black Prairie Belt, (3) Southern Hills, and (4) Alluvial-Deltaic Plain (fig. 3). The Coastal Plain is underlain by Mesozoic- and Cenozoic-age sediments and sedimentary rocks that dip gently westward and southward at about 20 to 40 feet per mile (ft/mi) and increase to as much as 50 ft/mi near the coast (Davis, 1988). Outcrops of resistant beds form asymmetrical ridges that gently slope southward forming a series of curved, hilly belts trending southeast to east. The location of each district is determined largely by the geologic character of the underlying sediments.

The Fall Line Hills is a dissected upland with a few broad, flat ridges separated by valleys ranging from 100 to 200 feet deep. The Fall Line Hills occupies a zone where streams descend from resistant sedimentary and crystalline rocks of the Piedmont, Valley and Ridge, and Cumberland Plateau Physiographic Provinces to the less resistant sand and clay of the Coastal Plain. Altitudes range from more than 700 feet above sea level in the northwestern part of the basin to about 250 feet above sea level along the northern edge of the Black Prairie Belt.

The Black Prairie Belt lies to the south and west of the Fall Line Hills and occupies a crescent-shaped area, extending from northeastern Mississippi into central Alabama. The area is characterized by an undulating, deeply weathered plain of low relief. Valley bottoms lie at altitudes of about 250 feet above sea level (Davis, 1988). The Black Prairie Belt is underlain by chalk of Cretaceous age.

The Alluvial-Deltaic Plain is a flat expanse characterized by sinuous stream courses, swamps, and poorly defined drainage divides. The district is separated into Quaternary-age alluvial deposits of sand, gravel, clay, and silt that make up the flood plains and river terraces along the major rivers in the Mobile River system (Stephenson and Monroe, 1940), and deltaic deposits that form the flood plains along the tidally influenced streams in the southernmost part of the basin (fig. 3).

The Southern Hills (fig. 3) lies west and south of the Black Prairie Belt and is characterized by a series of hills underlain by sediments and poorly consolidated sedimentary rocks (O'Hara, 1996; Sapp and Emplaincourt, 1975). The northernmost series of hills is the Pontotoc Ridge in northeastern Mississippi and the Chunnenuggee Hills in Alabama. The Pontotoc

Ridge and Chunnenuggee Hills are a pine-forested series of sand hills and cuestas (or hogback ridges) developed on chalk beds to the west and on more resistant clay, siltstone, and sandstone to the east. The North Central Hills and Southern Red Hills lie at an altitude of about 600 feet above sea level, with local relief of several hundred feet. Contained within this area is a somewhat flat-lying surface known as the Flatwoods.

The Lime Hills extend eastward from near the Alabama-Mississippi State line. Resistant sedimentary rocks contribute to relief of 200 to 250 feet from valley floors to ridge crests.

The Southern Pine Hills is the southernmost of the series of hills in the Southern Hills district. Developed on Miocene-age estuarine deposits to the north and on sand and gravel of Pliocene age to the south, the Southern Pine Hills form an elevated southward sloping dissected plain, which ranges in altitude from about 100 to 400 feet above sea level.

Geology

The major geologic units comprising the basin and described in this report were modified from King and Beikman (1974) (fig. 4). The study area can be divided into four broad categories of geologic structure: (1) flat-lying Paleozoic-age sedimentary rocks that underlie the Cumberland Plateau; (2) Paleozoic-age sedimentary rocks folded into a series of anticlines and synclines in the Valley and Ridge Physiographic Province, where resistant rocks form ridges and more easily eroded rocks underlie the valleys; (3) intensely deformed metamorphic rocks that have been intruded by small to large bodies of igneous rocks in the Piedmont and Blue Ridge Physiographic Provinces; and (4) gently dipping, poorly consolidated to unconsolidated sediments of the Coastal Plain (Miller, 1990).

The Valley and Ridge Physiographic Province is characterized by a succession of subparallel northeast-trending ridges that are composed of cherty limestone, dolomite, and sandstones; the valleys are developed in more soluble limestone, dolomite, and shale (DeBuchananne and Richardson, 1956). These Paleozoic-age rocks of fluvial and marine origin are folded, faulted, and thrusted clastic and carbonate rocks that have been only locally metamorphosed (Mooty and Kidd, 1997). Predominant rock types are, in order of abundance, carbonate rock (dolomite and limestone), shale, and sandstone (Colton, 1970).

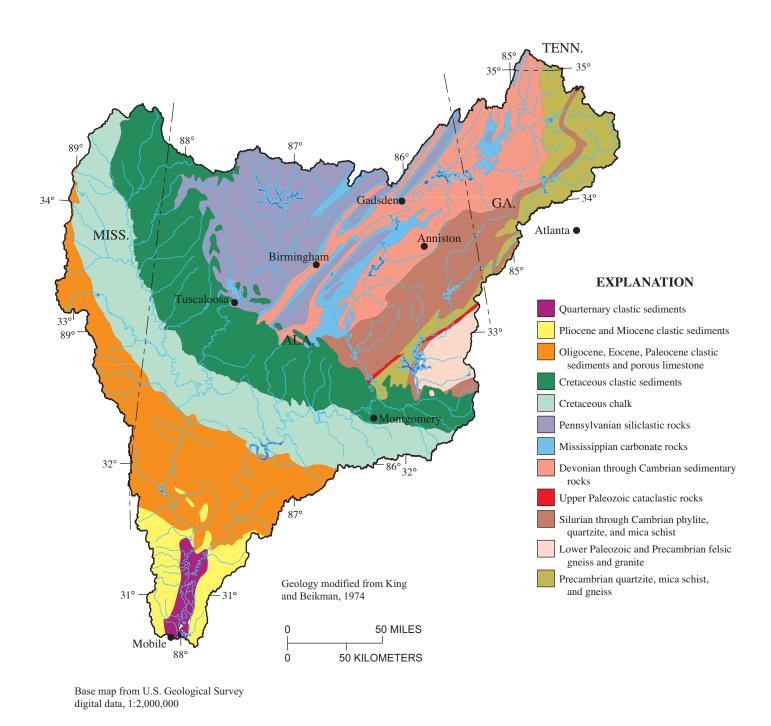


Figure 4. Generalized geology of the Mobile River Basin.

The Cumberland Plateau Physiographic Province also is underlain by rocks of Paleozoic age. These rocks are similar to those in the Valley and Ridge, but deformation of rocks is less intense than that found in the Valley and Ridge (Robinson and others, 1997). The bedrock is a sequence of mostly horizontal Pennsylvanian sandstone, shale, conglomerate, and coal and is underlain by Mississippian-age and older shale and carbonates. The Pennsylvanian-age rocks have low permeability except where fractured (Zurawski, 1978).

The Piedmont and Blue Ridge Provinces are underlain by complex sequences of igneous rocks, mostly granites and lesser amounts of diorite and gabbro, of Precambrian to Paleozoic age and extensively folded and faulted metamorphic rocks of late Precambrian to Permian age (Miller, 1990); in the Piedmont, isolated igneous rocks of Mesozoic age also are present (Chapman and Peck, 1997). The rocks are characterized by a complex outcrop and subsurface distribution pattern, and can vary significantly on the scale of a few tens of feet within the same lithologic unit. The Piedmont contains major fault zones that generally trend northeast-southwest and form the boundaries between major rock groups (Georgia Geologic Survey, 1976). The regolith covering these crystalline igneous and metamorphic rocks ranges in thickness from a few to more than 150 feet, depending upon the type of parent rock, topography, and hydrogeologic history. Regolith thickness generally is less in the Blue Ridge Province than in the Piedmont because of the steeper slopes (Schmitt and others, 1989; Brackett and others, 1991).

The Coastal Plain Physiographic Province is underlain by a thick wedge of unconsolidated to poorly consolidated clastic and carbonate rocks, which dip generally toward the west and southwest in the western part of the study area and toward the Gulf of Mexico in the southern part. Cyclic transgressions and regressions of the sea occurred during the Cretaceous and Tertiary periods, which deposited the sediments that now make up the Coastal Plain Physiographic Province (Mallory, 1993). The Cretaceous sediments are of fluvial and marine origin. Older units are exposed near the Fall Line, and progressively younger units crop out at land surface to the west and south toward the Gulf of Mexico. The thickness of sediments increases downdip to an estimated 21,000 feet near the coast (Davis, 1988).

Soils

Soil is a natural mixture of mineral and organic ingredients. The type of soil formed in a particular region is strongly influenced by the climate, parent material, landscape relief, and biological factors. These factors interact dynamically over a period of time ranging from recent events to ancient times to produce soil profiles that vary with depth and complexity.

The wide range of geologic, topographic, and climatic conditions in the Mobile River Basin produce widely varying soil types. The various soil types are used to divide the basin into seven Major Land Resource Areas (MLRA): the Eastern Gulf Coast Flatwoods, Southern Coastal Plain, Blackland Prairies, Southern Appalachian Ridges and Valleys, Sand Mountain, Southern Piedmont, and Blue Ridge (fig. 5). An MLRA is a geographic land area characterized by a particular combination or pattern of soils. climate, water-resources, land-use, and agricultural practices. Detailed county-scale soil surveys identify several major soil series within each MLRA. A soil series is a part of the land area with similar soil properties, such as color, texture, soil horizons, and depth to bedrock (U.S. Department of Agriculture, Soil Conservation Service, 1981).

The Eastern Gulf Coast Flatwoods, the Southern Coastal Plain, and the Blackland Prairies MLRAs are located within the Coastal Plain Physiographic Province. The Eastern Gulf Coast Flatwoods overlaps the Alluvial-Deltaic Plain district in the southern part of the Mobile River Basin. The soil series comprising this MLRA consist primarily of the peaty, mucky Dorovan, the sandy loamy Osier, and the loamy Cahaba series, all of which are poorly drained. The Southern Coastal Plain includes the Southern Hills district and the Fall Line Hills district of the Coastal Plain Physiographic Province. A distinction exists between soil characteristics in the Fall Line Hills and the Southern Hills districts. The soils of the Fall Line Hills district consist mainly of the Smithdale, Luverne, and Savannah soil series, which have a sandy loam or loam surface and loamy or clayey subsoil underlain by a dense, impermeable layer or fragipan. The soils of the Southern Hills district in the study area consist mainly of the Smithdale and Luverne series, which have a clayey loamy subsoil (U.S. Department of Agriculture, Natural Resources Conservation Service, 2001).

The Black Prairie Belt district and the corresponding Blackland Prairie MLRA were named for the dark surface colors of the clayey soils, which are formed from alkaline chalk or acid marine clay

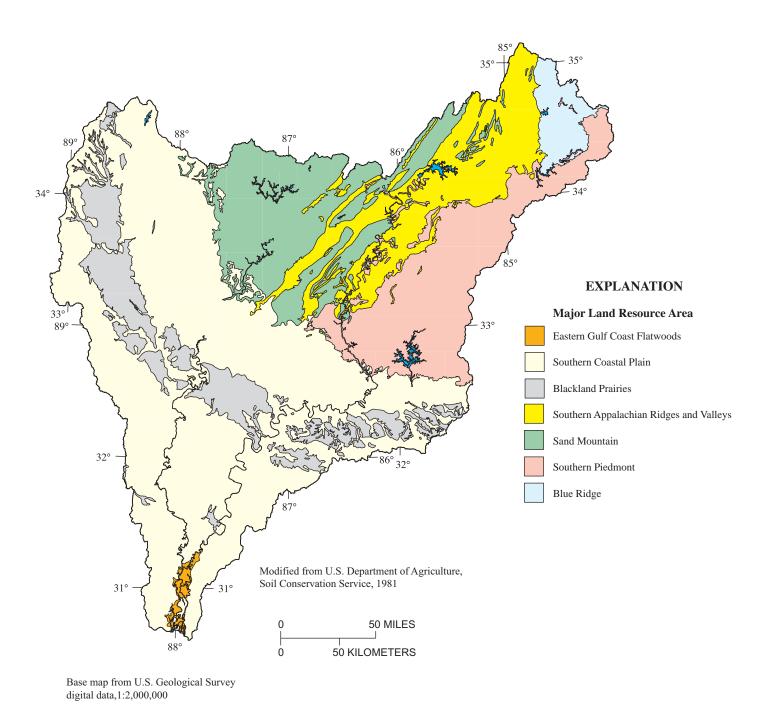


Figure 5. Major land resource areas within the Mobile River Basin.

deposits. These clayey soils (vertisols) have low infiltration; they shrink and crack when dry and swell when wet. Sumter soil series typically overlie the chalk deposits and the Oktibbeha soil series are typical of the marine clay.

The Valley and Ridge Physiographic Province is included in the Southern Appalachian Ridges and Valleys MLRA. Soils formed in the valleys in this region differ from those formed on the ridges. Soils in the valleys of the Southern Appalachian Ridges and Valleys were formed mainly in residuum of weathered limestone and are predominantly red, iron- and clayrich types with silt loam surface textures. Decatur and Dewey soils are common soil series in the valleys. The ridges consist of cherty limestones that produce a gravelly loam and gravelly clay subsoil and a gravelly silt loam surface layer. Bodine and Fullerton soil series cover an extensive part of this landscape.

The Sand Mountain MLRA consists of soils formed on the Cumberland Plateau. The soils are derived from the predominant sandstone and shale units. The soils are gravelly to clayey loam of the Montevallo and Townley series, which are found along the steep slopes, and loamy to clayey loamy soils of the Hartselle, Wynnville, and Albertville, which are present in the valleys and found along flatter slopes.

The soils of the Southern Piedmont MLRA are formed from the weathering of crystalline rocks, such as granite, gneiss, mica schists, and slate. The soil types range from clayey loamy soils over schist and slate to gravelly loamy soils over gneiss and granite. The clayey loamy soils are predominantly Cecil, Tallapoosa, and Madison series, and the gravelly loamy soils are of Appling, Cecil, and Gwinnett series. These soils tend to be acidic and low in nitrogen and phosphorus.

The Blue Ridge MLRA comprises soils that formed within the Blue Ridge Physiographic Province from the weathering of crystalline and metamorphic rocks. Dominant soils of the Blue Ridge are moderately deep and medium textured. Ashe, Chandler, Edneyville, Porters, and Saluda series are the principal soils found on steep slopes. Clifton, Edneyville, Evard, Fannin, and Hayesville series are found on the ridge tops and side slopes of the rolling foothills. Bradson, Brevard, Dyke, Tate, and Tusquitee series are formed on foot slopes and in coves. Boulders and outcrops of bedrock are conspicuous but not extensive

on mountain slopes (U.S. Department of Agriculture, Natural Resources Conservation Service, 1992).

Climate

The climate in the Mobile River Basin is warm and humid, ranging from temperate at higher elevations to subtropical near the coast. The land-surface altitude and distance from the Gulf of Mexico are major factors influencing climate in the basin. In the summer months, the Gulf of Mexico produces warm, humid air masses that move inland and provide precipitation in the form of thunderstorms, especially near the coast. Arctic fronts that move south from the midwestern part of the continent contribute most of the precipitation in the winter months.

Precipitation in the Mobile River Basin is mainly rainfall with amounts evenly distributed throughout the year; a distinct dry period usually occurs during midsummer to late fall (fig. 6), but the pattern may be disrupted by tropical depressions, storms, and hurricanes, which enter the Gulf of Mexico and move inland in the late summer and early fall. These storms may produce an overabundance of rainfall and flooding. Snowfall accumulation is rare, with annual averages generally less than an inch. Areas of the basin with higher altitudes, such as Rome, Ga., and Birmingham, Ala., have an average annual snowfall of about 2 inches.

Mean annual precipitation (fig. 6, table 1) from 1961 through 1990, ranged from 53.4 in/yr in Montgomery, Ala., in the eastern part of the basin, to 64 in/yr in Mobile, Ala., near the coast (National Oceanic and Atmospheric Administration, 1998). Mean monthly precipitation data were obtained for five National Weather Service cooperative stations located within or near the Mobile River Basin at Mobile, Montgomery, and Birmingham, Ala., Atlanta, Ga., and Tupelo, Miss. The lowest mean monthly precipitation occurred in October, and ranged from 2.45 to 3.42 inches for Montgomery and Tupelo, respectively. Generally, the highest mean monthly precipitation occurred in March and ranged from 5.77 to 6.26 inches for Atlanta and Montgomery, respectively. Exceptions included Mobile, where the highest mean monthly precipitation occurred during the periods of greatest tropical activity in July and August (6.85 and 6.96 inches, respectively), and Tupelo, where the highest mean monthly precipitation was in December (6.16 inches) and the lowest was in August (3.05 inches).